

What is claimed is:

1. A structure comprising:
 a reference member having a raised portion thereon;
 a mirror suspended above the raised portion; and
 driving devices disposed on the raised portion to
5 impart rotational motion to the mirror in two axes of direction.
2. The structure of claim 1, wherein the raised portion
 has a conical shape.
- 10 3. The structure of claim 1, wherein the raised portion
 has a quasi-conical shape.
4. The structure of claim 1m wherein the raised portion
 has a polygonal shape.
- 15 5. The structure of claim 1, wherein the mirror is
 coupled to the reference member by torsion hinges, and wherein
 the torsion hinges each comprise multiple, parallel vertical
 slots therein, the slots serving to partition the torsion hinge
20 into narrow sections having a lower torque constant than the
 torsion hinge without such slots.
6. The structure of claim 5, wherein the narrow sections
 and vertical slots serve to maximize lateral and vertical
25 stiffness while minimizing the torsional spring constant of the
 torsion hinges.
7. The structure of claim 5, wherein the torsion hinges
 include a torsional sensor.

8. The structure of claim 5, wherein the slots are etched through the full thickness of the hinge.

5 9. The structure of claim 1, further comprising:

a mirror frame, the mirror being coupled to the mirror frame by a first pair of torsion hinges located along a first, inner rotational axis and the mirror frame being coupled to the reference member by a second pair of torsion hinges located
10 along a second outer rotational axis; and

wherein torsion hinges in each pair include a torsion sensor coupled to a torsion sensor select circuit, the torsion sensor select circuit for selecting one of the torsion sensors as active.

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10. The structure of claim 9, wherein each of the torsion sensors has an input and an output and wherein the torsion select circuit includes select lines for selectively coupling the input of one of the sensors to a current source and the
20 output to an instrumentation amplifier.

11. The structure of claim 9, wherein the driving device are electrodes that are quartered to form electrodes in four corresponding quadrants of the raised portion.

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12. The structure of claim 11, wherein the quartering is generally parallel to a first, inner rotational axis and the second, outer rotational axis.

30 13. The structure of claim 11, wherein the quartering is

offset from the first, inner rotational axis and the second, outer rotational axis by approximately 45 degrees.

14. The structure of claim 11, further comprising a servo
5 control unit, comprising:

an amplifier circuit for driving a corresponding one of the electrodes, the amplifier circuit receiving as inputs a biasing voltage and feedback signals from the torsion sensors, the inputs being weighted for each electrode and the feedback
10 signals being inverted as necessary according to direction of rotation.

15. The structure of claim 1, wherein the reference member is a silicon substrate and the mirror is defined in an SOI top
15 layer.

16. The structure of claim 15, further including an intermediate silicon layer disposed between the silicon
20 substrate and the SOI top layer.

17. The structure of claim 15, further comprising sense amplifiers and currents sources embedded in the SOI top layer.

18. The structure of claim 15, further comprising sense
25 amplifiers and currents sources embedded in the silicon substrate.

19. The structure of claim 1, wherein the mirror is coupled to the reference member by torsion hinges and the
30 torsion hinges each comprise a torsion hinge having a steep

return to the mirror to minimize bending on the mirror frame.

20. The structure of claim 1, wherein the mirror is coupled to the reference member by torsion hinges and the torsion devices each comprise a folded torsion hinge having flexible members coupled by vertically stiff inner and outer members, the inner and outer members being tied together by a torsionally flexible, vertically stiff torsional element.

10 21. The structure of claim 1, wherein the mirror is coupled to the reference member by torsion hinges and wherein the torsion devices each comprise a bending hinge including connection members which are connected by bands that are connected by end portions, wherein corresponding ones of the end portions in each band are connected by a torsion element that enables the end portions to rotate with respect to each other while being held together vertically.

22. The structure of claim 9, wherein the torsion members, the mirror and the torsion sensors are fabricated to be of different thicknesses.

23. The structure of claim 1, wherein the driving devices are electrodes and the electrodes are made of a highly resistive material.

24. The structure of claim 23, wherein the highly resistive material is polysilicon.

30 25. The structure of claim 24, wherein the electrodes are

coated with an insulating material in locations of the electrodes that may be in contact with the mirror.

26. The structure of claim 9, wherein the torsional
5 sensors each comprise a shielded sensor structure including a sensor implant layer and a shield applied over the sensor implant layer to stabilize sensor output and eliminate light sensitivity of such torsional sensor.

10 27. A method of fabricating micro-mirror structures in a micro-mirror strip of micro-mirror structures comprising:
forming a pyramidal structure from a substrate material; and
defining electrodes on the pyramidal structure.

15 28. The method of 27, wherein forming the pyramidal structure comprises:
anisotropic etching the pyramidal structure to form
15 steps of various depths in the structure.

29. The method of claim 27, wherein the electrodes include
20 four electrodes and forming the electrodes further comprises
arranging each electrode on a different one of quadrants of the pyramidal structure.

30. The method of claim 28, wherein the steps are polygonal
25 in shape.

31. The method of claim 27, wherein a second wafer is bonded to the processed wafer.

32. The method of claim 31, wherein the second wafer is a silicon-on-insulator wafer and is bonded to the wafer with a device side facing the wafer.

5 33. The method of claim 31, further comprising:
disposing a material to define a mirror in a surface of the second wafer.

10 34. The method of claim 31, further comprising:
defining sensors in the surface of the second wafer.

35. The method of claim 27, further comprising:
adding dam structures to the wafer to isolate the
15 structure from adjacent micro-mirror structures in a strip of micro-mirror structures.

36. The method of claim 34, further comprising:
defining other electronic components of the micro-
20 mirror structure in one or the other of the wafers.

37. A hinge comprising:
a plurality of parallel hinge sections provided by
vertical slots therein, the slots and parallel hinge sections
25 being dimensioned to provide vertical and lateral stiffness to
and a minimal torsion spring constant for the hinge.

38. A micro-mirror strip assembly comprising:
a frame;
an array of two-dimensional deflecting mirrors mounted

in the frame; and

5 dams disposed between the mirrors to block viscous
interaction between each of the two dimensional deflecting
mirrors and adjacent ones of the two-dimensional deflecting
mirrors in the array.

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